

PAO Formative Assessments for Science Online Repository



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Billings, MT



Montana's Initial Steps Toward Developing Formative Science Assessments

Objectives

- **Reverse-engineer** (take existing assessment materials aligned to the *Framework*) and **APPLY** them to formative need
- **Use UbD step-wise process** to consider instructional strategies
- **Offer guidance** on accessibility, equity and engagement
- **Formulate a process** with alignment and purpose embedded
- **Provide** rubrics and tools to review materials for quality
- **Empower** local educators in the process

1. Children are born investigators



feedback used to

- **Formative Assessment** - is a deliberate process to adjust ongoing teaching and learning strategies

2. Focusing on Core Ideas and Practices



3. Understanding Develops Over Time



4. Science and Engineering Require Both Knowledge and Practice



- **Formative Assessment** - is a deliberate process used by teachers and students during instruction that provides actionable feedback used to adjust ongoing teaching and learning strategies to improve students' attainment of curricular learning targets/goals.

5. Connecting to Students Interest and Experiences



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6. Promoting Equity

Indian Education For All



Integrating quality Indian Education for All content with rigorous, standards-based instruction in all curriculum areas

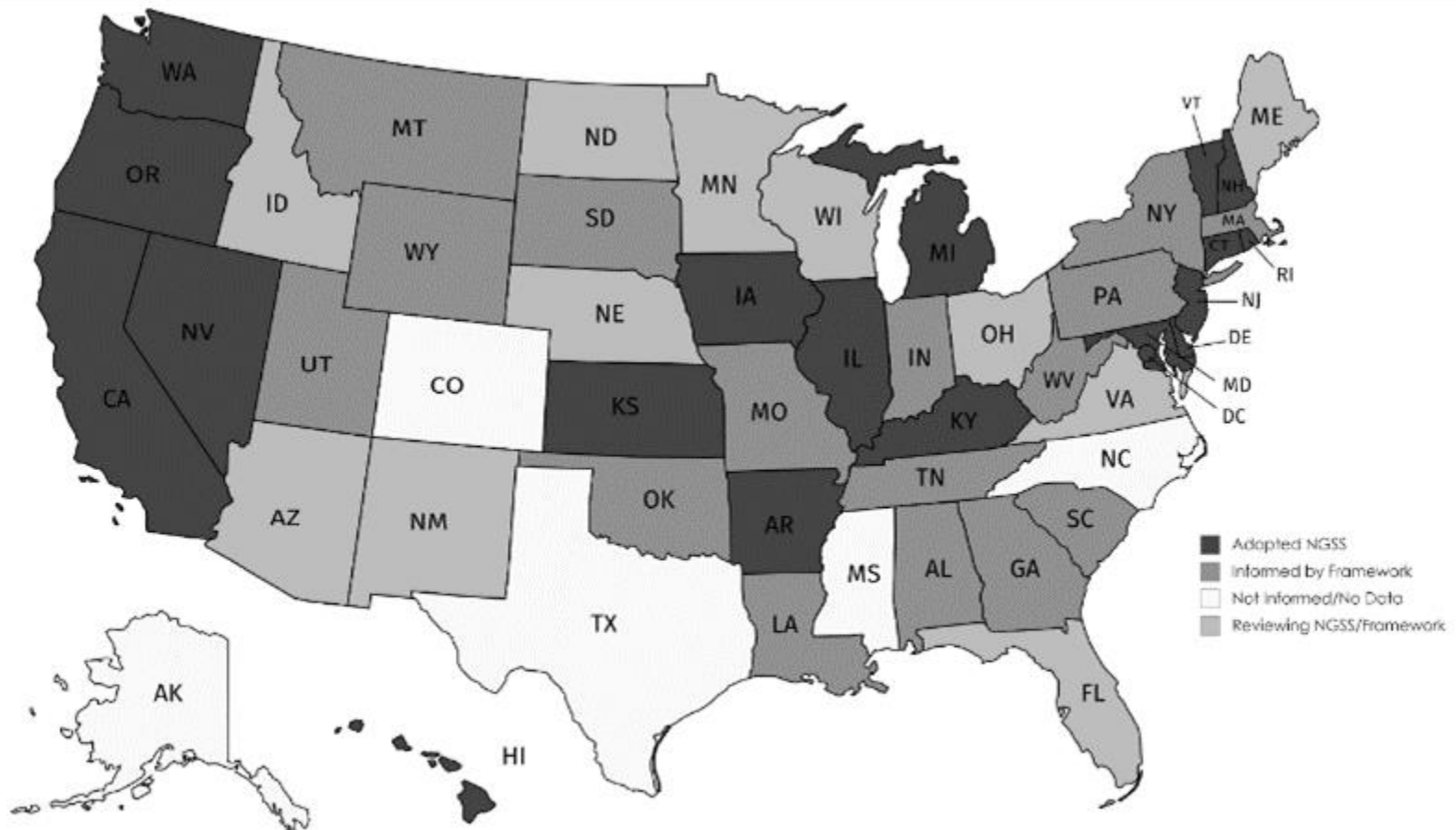
- **Formative Assessment** - is a deliberate process used by teachers and students during instruction that provides actionable feedback used to adjust ongoing teaching and learning strategies to improve students' attainment of curricular learning targets/goals.

Conceptual Shifts of the Standards

1. K–12 Science Education Should Reflect the **Interconnected Nature of Science** as it is **Practiced** and **Experienced** in the **Real World**
2. MT Science Standards are student performance expectations – **NOT curriculum**
3. MT Science Standards Concepts **Build Coherently** from K–12
4. MT Science Standards **focus on Deeper Understanding** of Content as well as **Application** of Content
5. **Science and Engineering are Integrated** in the MT Science Standards
6. MT Science Standards are designed to prepare students for **college, career, and citizenship**
7. MT Science Standards and Common Core State Standards (English Language Arts and Mathematics) are **Aligned**

[Source Appendix A](#)

NGSS and Framework-Based State Adoptions

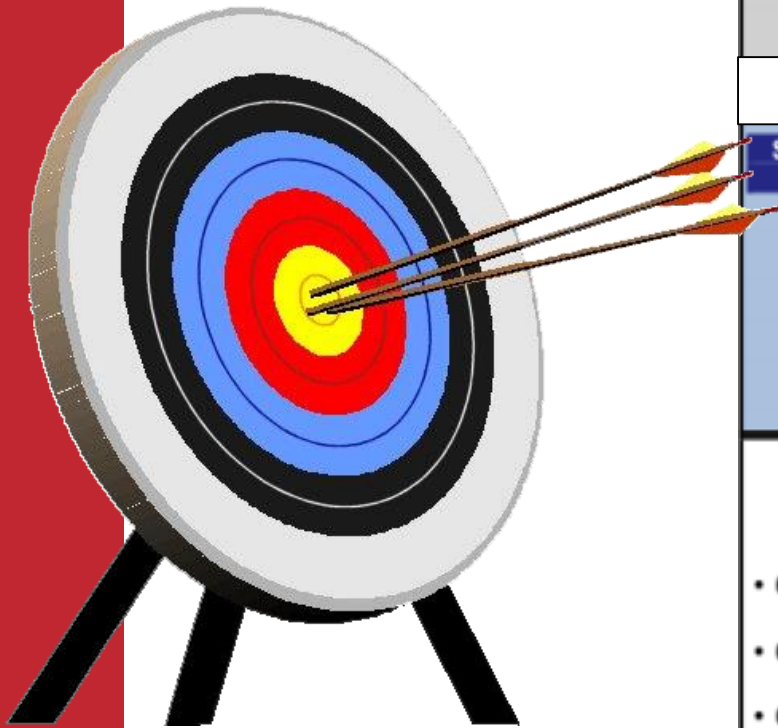


Updated last as of April 2017

- **Formative Assessment** - is a deliberate process used by teachers and students during instruction that provides actionable feedback used to adjust ongoing teaching and learning strategies to improve students' attainment of curricular learning targets/goals.

Standards Context

What students should
KNOW and be able to DO



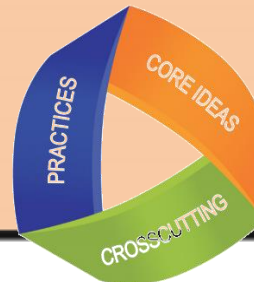
Performance Expectations

Foundation Boxes

Science and Engineering
Practices

Disciplinary
Core Ideas

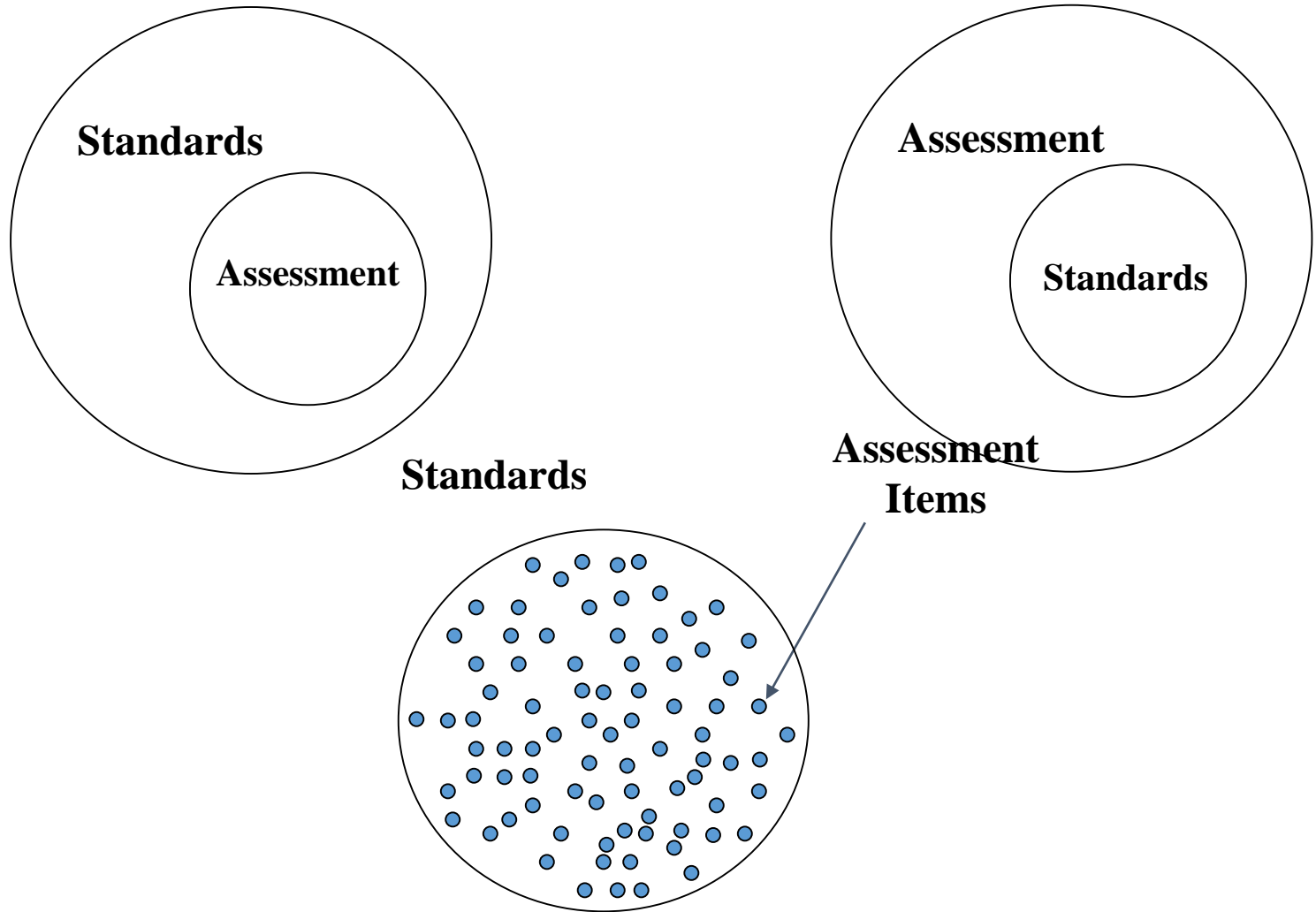
Crosscutting
Concepts



Connections to

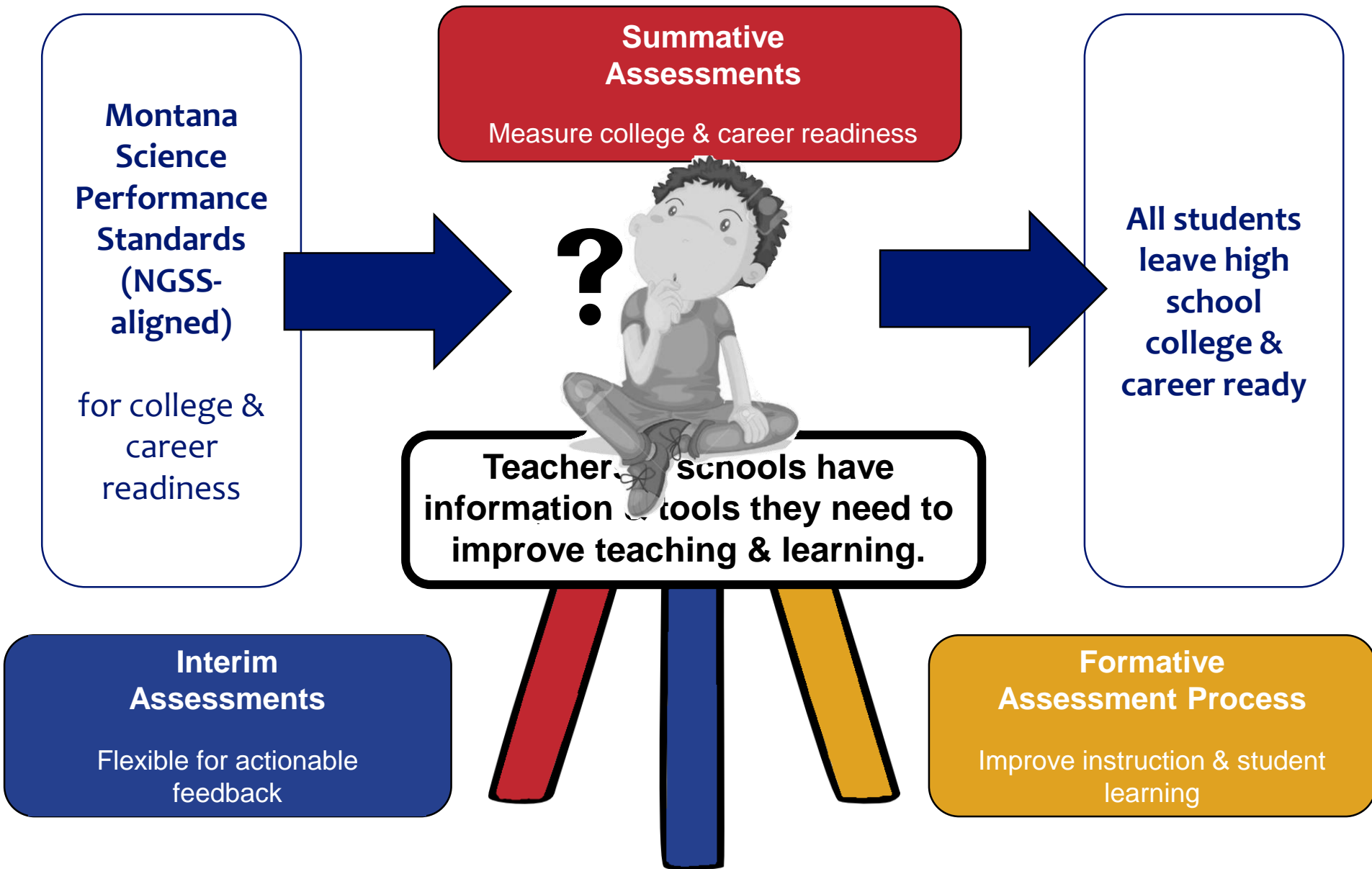
- Other science disciplines at this grade level
- Other DCIs for older and younger students
- Common Core State Standards in Mathematics and Language Arts

What to Measure?



- **Formative Assessment** - is a deliberate process used by teachers and students during instruction that provides actionable feedback used to adjust ongoing teaching and learning strategies to improve students' attainment of curricular learning targets/goals.

Re-envision Assessments for Science



Theory of Action (ToA) Overview

Statewide Assessment Design System (SADS)

Montana is a local-control state and as such the OPI will work with the BPE and partners to implement changes that are reasonable and responsive to the unique educational circumstances of Montana's K–12 accredited schools.

System Setting and Use (SSU)

Montana's state and local science assessments measure the MCS (2016) for science knowledge, skills, and abilities essential for community, college, and workforce readiness.

Teacher Actions (TA)

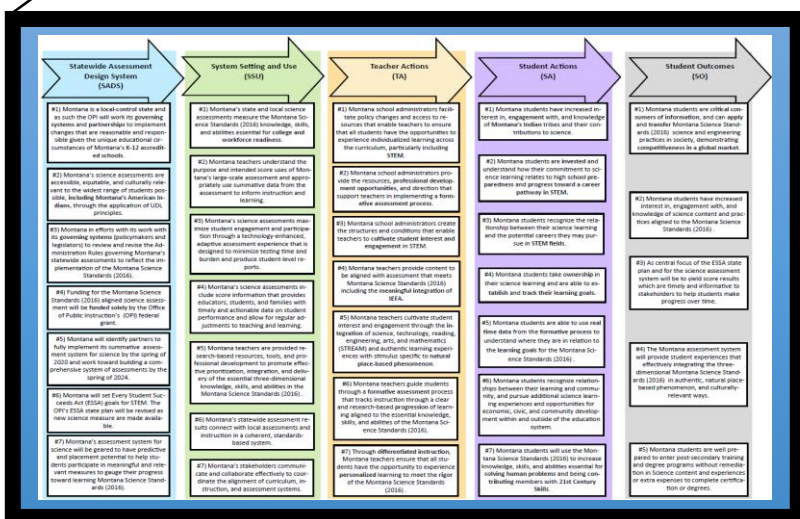
Montana school administrators facilitate policy changes and access to resources to support teachers and students with opportunities to experience individualized learning across the curriculum including STEM and having access to technology.

Student Actions (SA)

Montana school administrators facilitate policy changes and access to resources to support teachers and students with opportunities to experience individualized learning across the curriculum including STEM and having access to technology.

Student Outcomes (SO)

Montana students are critical consumers of information and can apply and transfer MCS (2016) for science learning to complex and novel situations thus demonstrating globally competitive skillsets necessary for postsecondary success.



[Click to access ToA](#)

What is Formative Assessment?



Formative Assessment Process

Formative assessment is a **deliberate process** used by teachers and students **during instruction** that provides **actionable feedback** used to **adjust** ongoing teaching and learning strategies to improve students' attainment of curricular learning goals. There are four attributes in the Formative Assessment Process, represented graphically as a clover.

A Balanced Assessment System

The Smarter Balanced Assessment Consortium is committed to ensuring that all students leave high school prepared for postsecondary success. A balanced assessment system—which includes the formative assessment process as well as interim and summative assessments—provides tools to improve teaching and learning. The formative assessment process is an essential component of a balanced assessment system.

DIGITAL LIBRARY

An online collection of thousands of educator-created classroom tools and resources



INTERIM ASSESSMENTS

Optional and flexible tests given throughout the year to help teachers monitor student progress

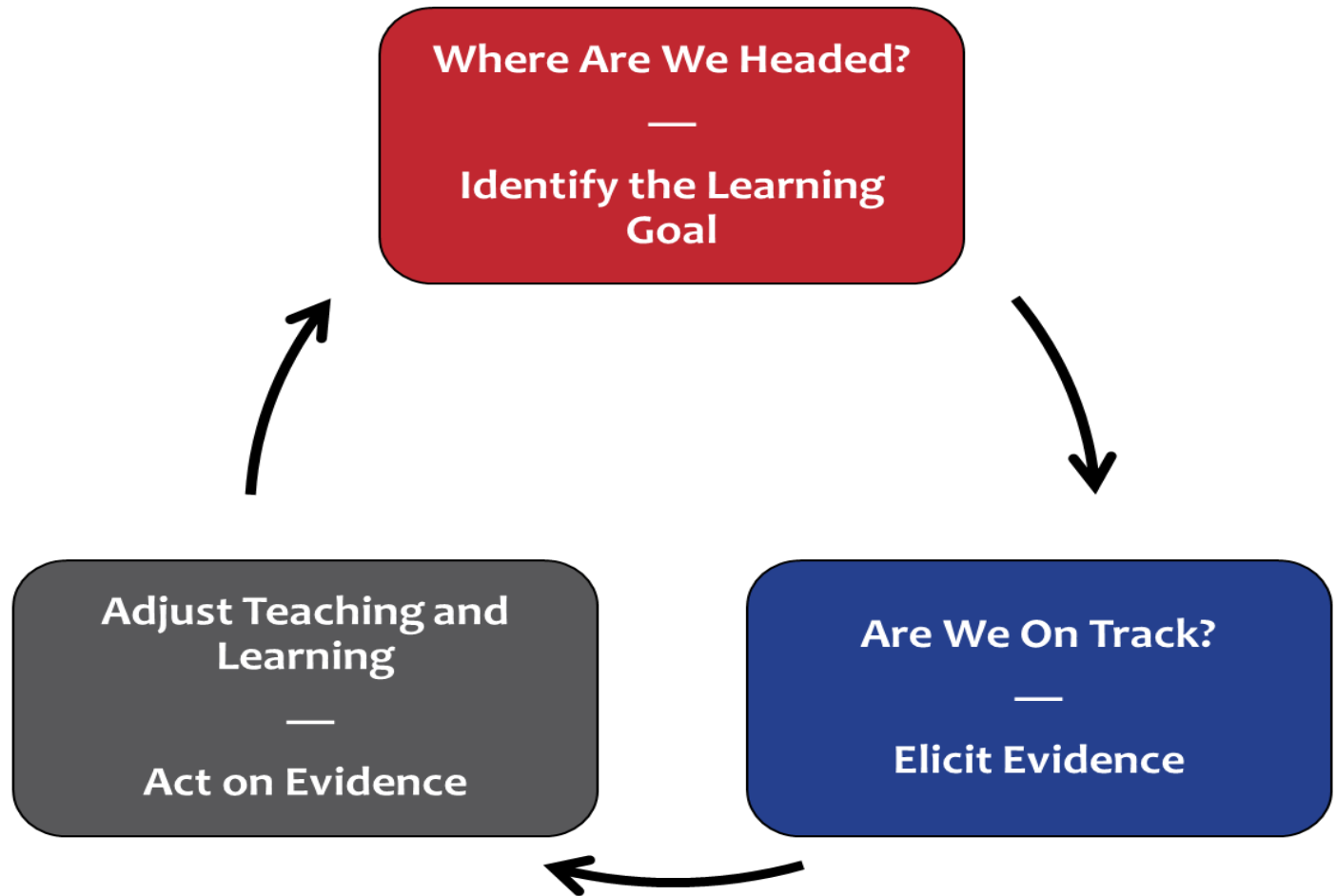


SUMMATIVE ASSESSMENTS

Year-end assessments for grades 3–8 and 11 in math and English language arts/literacy



PAO Formative Assessment



- **Formative Assessment** - is a deliberate process used by teachers and students during instruction that provides actionable feedback used to adjust ongoing teaching and learning strategies to improve students' attainment of curricular learning targets/goals.

What is PAO Science?



Last Row: Marshall Lagge, Bruce Dudek
Sixth Row: Amanda Obery, Emily Currier, Karla Miller, Jessica Eilertson, John Deming, Jared Betz
Fifth Row: Chris DeWald, Jennifer Stadum, Sue Mohr, Lily Haines, Nicole Kirschten
Fourth Row: Ashley McGrath, Katie Burke, Melissa Johnson, Lindsay Manzo, Debbie Hanson
Third Row: Maureen Karlin, Jacqueline Marshall, Michelle McCarthy, Brian Williams
Second Row: Jodi Hall, Audrey Howard, Roni Sells, Monica Tomayer, Katherine Aune
Front: Karen Pollari, Marcy Fortner, Yvonne Field, Molly Ward, Mary Williams, Summer Graber



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NAVIGATION

HOME

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[GRADE](#)

[INDIAN EDUCATION FOR ALL](#)

[PRACTICES](#)

[SCIENCE DOMAIN](#)

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[SUBMIT A FORMATIVE RESOURCE](#)

[RECENT SITE ACTIVITY](#)

PAO Science Resource Overview



Process • Assessment • Outcome

All Montana Formative Science Resources were created to identify the instructional process(es), intended assessment, and expected student outcomes (PAO process) of the Montana Science Standards (2016). Teachers can use the PAO process to identify:

- The Learning Goal — “What is taught?” and/or “where are we headed?”;
- The Evidence Production and Action — “What has been learned and how do I know?”, “what gap exists?”, “are we on track?”;
- The Learning Outcomes — “How do we close the learning gap?” and “what actions do I/we need to take?”.



PAO resources provide guidance on how the educators can act on evidence to support ongoing teaching and learning to identify and close student learning gaps. Resources include instruction on how to provide ideas for eliciting student evidence to support instruction aligned to the Montana Science Standards (2016).

Explore a Dimension:

Disciplinary Core Ideas (Content)

Practices (SEPs)

Crosscutting Concepts (CCCs)



Resource Goals

“Student-Constructed Rubrics to Build toward MS-ESS1-4 Expectations”

Resource or Activity Type

Activity

Phenomenon Type

Anchoring Phenomenon—Geologic Intrusion

Formative Activity Abstract

This type of formative strategy is best used as a check for understanding after the content has already been learned. By the end of Grade 8, this formative strategy will help students to have an understanding of the “analyses of rock strata and the fossil record” (A Framework for K-12 Science Education, p. 178). This activity helps students check in with their understanding of the identified learning goal (i.e., MS-ESS1-4) through deconstructing a typical constructed response summative item as a group. As a group, the teacher guides students to mastery of this concept by helping them recognize the levels of evidence needed for optimal comprehension. This activity also helps familiarize students with the concept of assessment through identifying features of performance and scoring.

Standard Alignment



MS-ESS1-4 | Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6 billion-year-old history.

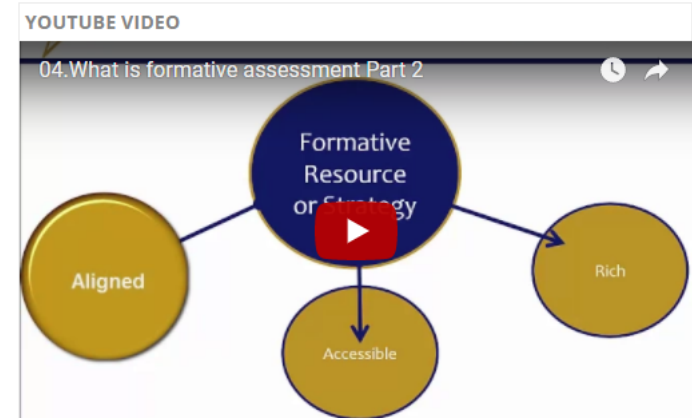
This formative strategy is well aligned to the content and practice with the opportunity to expand from constructing explanations into argumentation. This activity is not strongly aligned to the specific intersection of CCC 3 but it does strongly match the expectations for CCC 1.

Best alignment to: Middle School | ESS1.C | SEP 7 | CCC 1

Suggested Time for Activity

If students are unfamiliar with rubrics and constructed response scoring, we encourage teachers to complete the [pre-activity](#) first. The [pre-activity](#) should take roughly 45 minutes to complete. We anticipate the actual “Student-Constructed Rubrics” [activity](#) will take approximately 60–70 minutes to complete.

See this formative strategy in action!



Using the rating scale (1-5), please rate this activity.

RATE THIS STRATEGY!



- 1 – Awful.
- 2 – Poor.
- 3 – Average.
- 4 – Good.
- 5 – Excellent.

Resource Goals

- **Activity Closure and Success Criteria**
- **Assessable Targets**
- **Facets of Student Thinking - Instructional Tracker**
- **Activity Support and Accessibility Strategies**
- **Montana Indian Education for All (IEFA) Cultural Connections and/or Significance**

- **Past Learning:** Before middle school, students should have been exposed to the concepts of organisms and their role in food webs through concepts about energy transfer and exposure to terms like “producers,” “consumers,” and “decomposers.” In addition, the base concept is that organisms can survive only in environments in which their particular needs are met. By the time of this activity, middle school students should understand some of the elements that animals need to survive and what living and nonliving factors exist in an ecosystem (A Framework for K-12 Science Education, 151–152).
- **Present Learning:** With this activity and other lessons, by the end of Grade 8, students should know that organisms and populations of organisms are dependent on their environmental interactions with both other living things and nonliving factors. As a tenet of natural selection, the idea is that there is a relationship between the availability of resources and the organism’s survival needs and reproduction. In instances where requirements for food, water, oxygen, or other resources are limited resources, these factors can constrain the organism’s growth and reproduction. Students should understand examples of abiotic dynamics and biotic dynamics (e.g., competitive, predatory, and mutually beneficial interactions) and how these patterns of interactions between organisms and their environments, both living and nonliving, are shared (A Framework for K-12 Science Education, 151–152).
- **Future Learning:** Students should have a firm understanding of the past and present learning before they are ready for the next level of the learning progression, which is to identify the limits of these ecosystems through carrying capacities. These limits result from such factors as the availability of living and nonliving resources and from such challenges as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem (A Framework for K-12 Science Education, 151–152).

Assessable Targets

Note: These evidence statements identify the knowledge, skills, and abilities students should have prior to this activity.

What Should Students Know	What Should Students Be Able To Do
<ul style="list-style-type: none"> • MS-LS2-1.2.b) Students can determine whether the relationships provide evidence of a causal link between these factors. • MS-LS2-1.3.a.i-ii) Students can analyze and interpret the organized data to make predictions based on evidence of causal relationships between resource availability, organisms, and organism populations. Students make relevant predictions, including: <ul style="list-style-type: none"> o Changes in the amount and availability of a given resource (e.g., less food) may result in changes in the population of an organism (e.g., less food results in fewer organisms). o Changes in the amount or availability of a resource (e.g., more food) may result in changes in the growth of individual organisms (e.g., more food results in faster growth). • MS-LS2-4.1.a) Students can make a claim to be supported about a given explanation or model for a phenomenon. In their claim, students include the idea that changes to physical or biological components of an ecosystem can affect the populations living there. • MS-LS2-4.2.a.i) Students use reasoning to connect the appropriate evidence to the claim and construct an oral or written argument about the causal relationship between physical and biological components of an ecosystem and changes in organism populations, based on patterns in the evidence. In the argument, students describe a chain of reasoning that includes specific changes in the physical or biological components of an ecosystem cause changes that can affect the survival and reproductive likelihood of organisms within that ecosystem (e.g., scarcity of food or the elimination of a predator will alter the survival and reproductive probability of some organisms). • MS-LS2-5.1.a.ii) Students can identify and describe the given problem involving biodiversity and/or ecosystem services that is being solved by the given design solutions, including information about why biodiversity and/or ecosystem services are necessary to maintaining a healthy ecosystem. • MS-LS2-5.3.a.ii) Students can use reasoning, along with the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future, to connect the evidence and support an explanation for a phenomenon involving genetic and environmental influences on organism growth. Students describe their chain of reasoning that, because both environmental and genetic factors can influence organisms simultaneously, organism growth is the result of environmental and genetic factors working together (e.g., water availability influences how tall dwarf fruit trees will grow). • MS-ETS1-2.a.x) Students can identify the system in which the problem is embedded, including the major components and relationships in the system and its boundaries, to clarify what is and is 	<ul style="list-style-type: none"> • Students can identify the given design problem and solution using supporting evidence. • Students can reason and synthesize information to support a scientific explanation. • Students are able to analyze and interpret data to make predictions or provide evidence for phenomena. • Students are able to make a claim supported with evidence and sound scientific reasoning. • Students are able to connect evidence with reasoning. • Students are able to identify evidence and additional supporting evidence. • Students are able to interpret data to support a claim. • Students can define the process or system boundaries and the components of the process or system. • Students are able to identify cause and effect relationships that are used to predict phenomena in a designed system. • Students are able to use patterns to identify cause and effect relationships. • Students are able to construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. • Students can construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. • Students can evaluate competing design solutions based on jointly developed and agreed-upon design criteria. • Students can identify the systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. • Students can identify that systems may interact with other systems; they may have sub-systems and be a part of larger complex systems.

Lookup the 3-Dimensional Science Codes at:

[DCI Codes](#)

[SEP Codes](#)

[CCC Codes](#)

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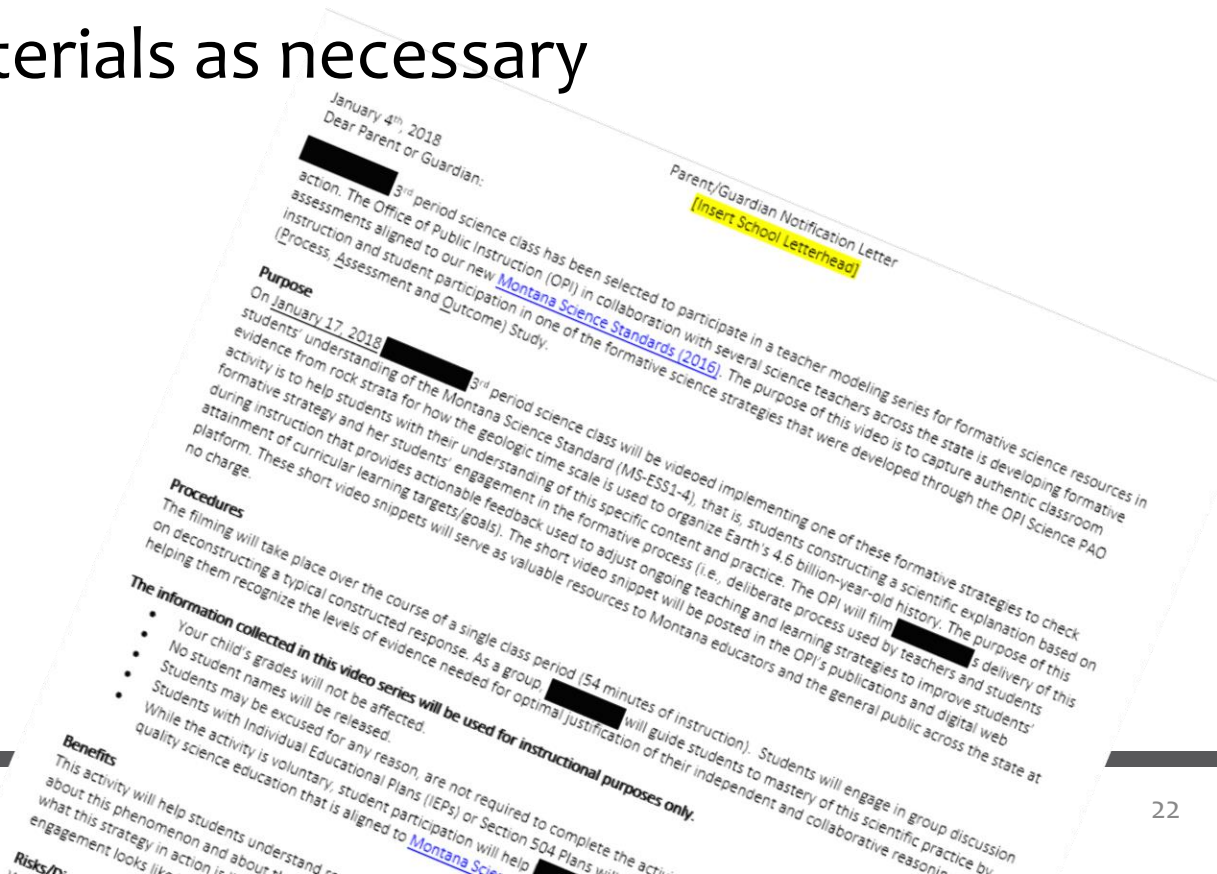
[CONTACT US](#)

Explore

- 21

Pilot Goals

- Test the resource template
- Test the process with rubrics and checklist
- Elicit input from piloting teacher
- Revise materials as necessary



- **Formative Assessment** - is a deliberate process used by to adjust ongoing teaching and learning strategies to improve

Resource in Action Goals

- High-quality & promotional in nature
- < 7 minutes in length (video snippet)
- Conversational preface & epilogue
- Model science strategy
- Capture authentic classroom instruction & student participation
- Collage of interaction
- Ensure overall goal of strategy is met



Methods I

- 30 educators were selected for this project, 25 completed
- Minimum of 15 hrs Teacher Learning Hub Training
- Leverage existing alignment work
- Reverse-engineer open, free materials
- Build proof-of-concept model to serves as an exemplar library for teachers



Methods II



- Hold 3-day face-to-face meeting
- Use UbD forms to reverse-engineer open, free materials
- Use consensus process to ensure quality
- Build proof-of-concept model to serves as an exemplar library for teachers

Methods III

Bucket resources into categories to support user-driven repository navigation:

- *Content-driven*
- *Content-neutral*
- *Activity-focused*
- *IEFA integration*
- *Special student population*



Methods IV

- Recruit piloting teacher
- Pilot resource and test process
- Merge the 94 resources into state template
- Test resource with PAO teachers using rubric, checklists, & repository goals
- Evaluate resource for inclusion with peers

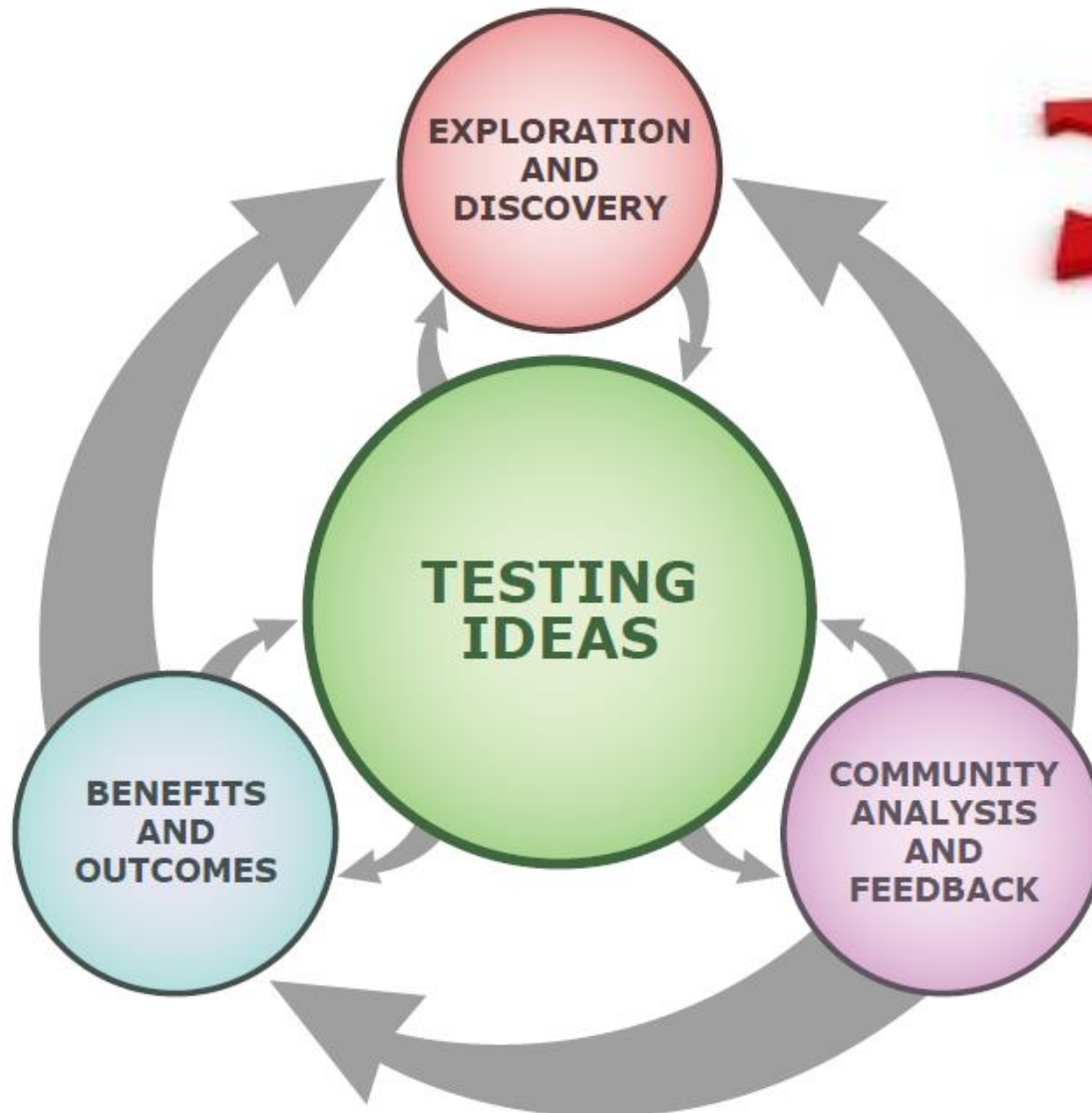


Methods V

- Vet the online repository resources
- Create an action plan for resources & piloting needs for the 2018-2019 school year
- Revise state phase-out/roll-out transition timeline for formative repository
- Create an action plan for a comprehensive, balanced system of assessments for science



PAO Project



PAO Phase I Findings

Facts:

- 25 teachers participated in this science formative development project.
- There were several teachers who participated on the team that wrote the Montana Science Standards (2016)
- Several informal science educators (e.g., educators from museums, science centers, etc. who work with teachers throughout the school year) were also participants.

PAO Phase I Findings

Benefits to State:

- This workshop increased teacher's knowledge of the new science standards and around developing formative assessments that measure these new standards.



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PAO Phase I Findings

Benefits to Teachers:

- “The course overall helped me grow. I appreciated the face-to-face experience the most, truly my best learning style”. – PAO Teacher Participant



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PAO Phase I Findings

Benefits to Students:

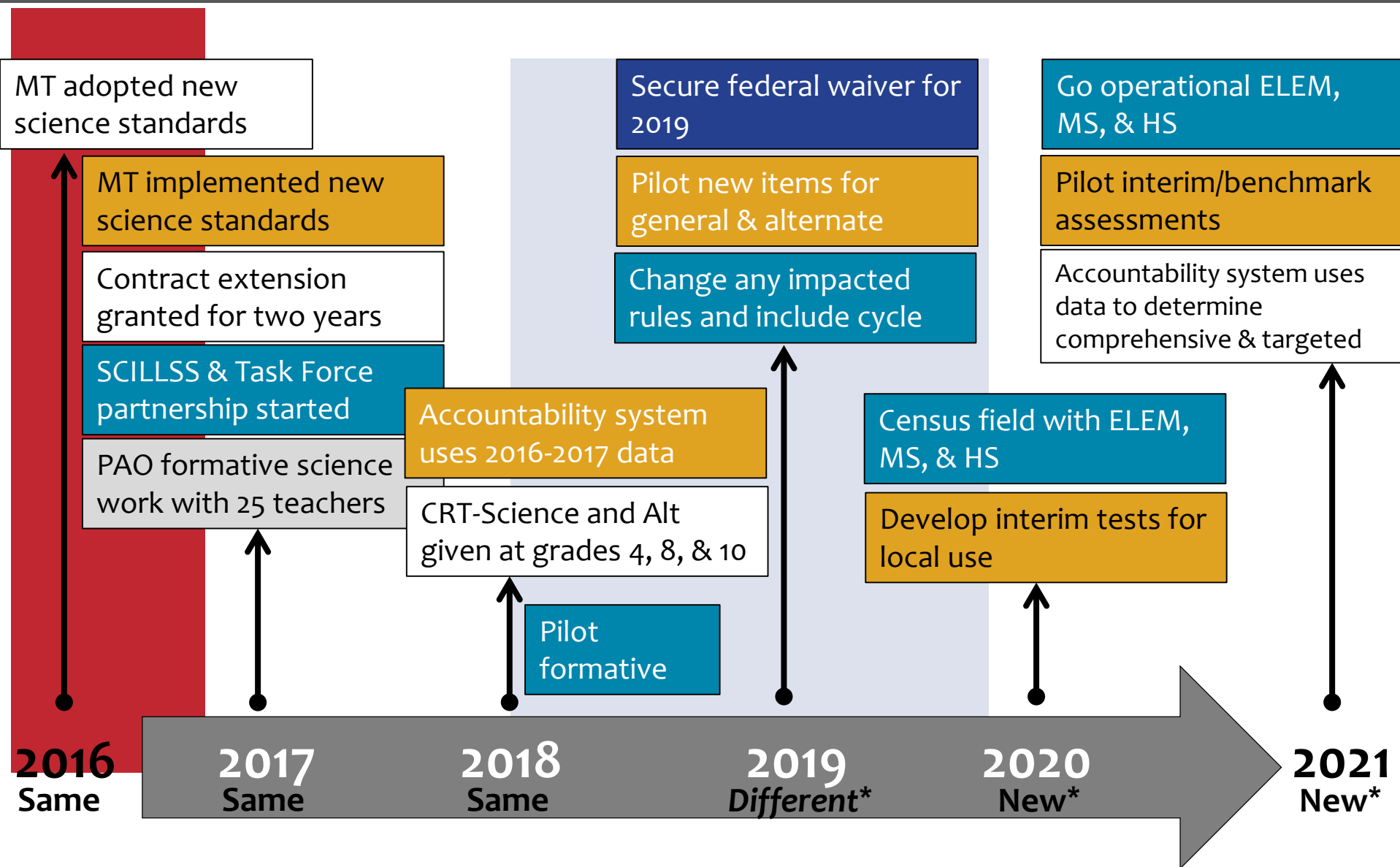
- Students of teachers who were a part of this workshop will have teachers who have more confidence teaching the new science standards and PAO formative assessment.



Conclusion

- Defined methods to help generalize and translate a backwards process to use with existing materials
 - Used a research-proven UbD stepwise process to consider resources while maintaining strong alignment and intention to the learning goals (standards).
 - To ensure alignment and appropriateness
 - To ensure specificity for teachers, local education agencies, and states
- Helped reduce teacher time by assembling a library of high-quality resources for teachers to select from
- Helped scaffold strategies as a formative process
- Provided expectations and structure for instructional concepts to consider in relation to the standards
- Engaged educators firsthand through its teacher-built and teacher-driven framework
- Invoked critical consumption of process-driven aligned strategies
 - Required educators to ask questions & to look critically at the necessary lines of evidence to know where the student is in relation to the learning goal (standards).
- Intentional iterative process ensured the project was responsive to improvement and teacher input
- Perfect launchpad to begin building a comprehensive system of assessments for science assessment system

Science Phase-Out / Roll-Out Idea



Student Constructed Rubrics

Handout 1) PAO Formative Resource

Montana Formative Science Resource
By Aubley McGrath and Michelle McCarthy

Activity Title - "Student-Constructed Rubrics to Build toward MS-ESS-4 Expectations"

Formative Activity Abstract
This type of formative strategy is best used as a check for understanding after the content has already been learned. This formative strategy will help students by the end of grade 8 to have an understanding of the "Analysis of rock strata and the fossil record" (A Framework for K-12 Science Education, p. viii). This activity helps students check in with their understanding of the identified learning goal (i.e., MS-ESS-4) through reconstructing a typical constructed response summative item as a group. As a group, the teacher guides students to mastery of this concept by helping them recognize the levels of evidence needed for optimal comprehension. This activity also helps familiarize students with the concept of assessment through identifying features of performance and scoring.

Alignment
MS-ESS-4 - Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6 billion-year-old history.
This formative strategy is well aligned to the content and practice with the opportunity to expand constructing explanations into argumentation. This activity is not strongly aligned to the specified crosscutting concept CCC: Systems and System Models.

Best alignment for: Middle School

Suggested Time for Activity | This activity does not have any prior knowledge. We encourage teachers to complete the activity in 1 class period.

Activity Description
What Does the Teacher Do?
Before this activity takes place the teacher should have familiarity with taking CR item activity, have students practice scoring a CR item. Follow the [instructions](#) for the activity.
After completing the pre-activity, the first teacher pre-identified CR item to demonstrate most recent rock formation, and explain it.

Link to the [Montana Science Center](#) at [opi.mt.gov](#) | [opi.mt.gov](#) | [opi.mt.gov](#)

Pre-Activity "How-To" Student Constructed Rubrics Instructional Guide

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Introduction	1
Conclusion	2
Practice Set #1 Alignment Details - Teacher Only	3
Practice Set #1 Anchor Set Question - PRINT	4
Practice Set #1 Score Rubric - PRINT	5
Practice Set #1 Example Student Response and Scores Cont. ... - PRINT	6
Practice Set #1 Example Student Response and Scores Cont. ... - PRINT	7
Practice Set #1 Scorer Notes and Scores - PRINT	8
Practice Set #1 Scorer Notes and Scores Cont. ... - PRINT	9
Practice Set #1 Try to Score Sample Responses - PRINT	10
Practice Set #1 Try to Score Sample Responses Cont. ... - PRINT	11

Handout 2) Pre-Activity Discussion Guide

"How-To" Student Constructed Rubrics Instructional Guide

Table of Contents	
Introduction	1
Activity Instructions	2
Conclusion	3
Practice Set #1 Alignment Details - Teacher Only	4
Questions Identify and explain most recent rock formation - PRINT	5
Score Rubric Identify and explain most recent rock formation - PRINT	6
Follow graphic organizer - PRINT	7
Claim, Evidence, Reasoning Argumentation Rubric Example - PRINT	8

Handout 3) Activity Discussion Guide

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Questions?

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